

5 **WHAT IS CLAIMED IS:**

1. Substrate loading and unloading apparatus for automated loading and unloading of substrates in a vacuum environment, comprising a substrate holder with a substrate support table and locating means co-operable with the table to
10 cause a supported substrate to be pressed against and thereby located on the table, a vacuum vessel defining a loading and unloading chamber with a transfer port which is communicable in use with an evacuated region and permits transfer of the holder between the chamber and the region in a vacuum environment, and release means for withholding co-operation of the locating means and the table
15 and providing a temporary substrate support clear of the table so as to permit transfer of a substrate to and from the holder.

2. Apparatus as claimed in claim 1, wherein the locating means defines a reference plane for a top face of the supported substrate.

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3. Apparatus as claimed in claim 2, wherein the reference plane is defined by three spaced-apart contact points for contacting the substrate top face.

4. Apparatus as claimed in claim 3, wherein the contact points are provided
25 by contact surfaces of stop members disposed above the table and fixed relative to a body member of the holder.

5. Apparatus as claimed in claim 1, wherein the locating means comprises resilient means to cause a supported substrate to be biased towards the table.

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6. Apparatus as claimed in claim 5, wherein the resilient means comprises a resilient mounting of the table.

7. Apparatus as claimed in claim 6, wherein the resilient mounting comprises
35 at least one compression spring.

5 8. Apparatus as claimed in claim 7, wherein the resilient means comprises at least one leaf spring arranged to provide an anti-twist mounting of the table.

9. Apparatus as claimed in claim 5, wherein the release means comprises displacing means to displace the table against the direction of bias by the resilient
10 means.

10. Apparatus as claimed in claim 9, wherein the displacing means comprises at least one displacing member movable to engage and depress the table.

15 11. Apparatus as claimed in claim 10, comprising resilient restoring means to oppose movement of the displacement member to engage and depress the table.

12. Apparatus as claimed in claim 11, wherein the or each displacing member comprises a pusher carried by an upwardly and downwardly movable carrier
20 member and the displacing means comprises drive means to cause downward movement of the carrier member.

13. Apparatus as claimed in claim 12, wherein the drive means comprises lever means drivably engaging the carrier member and actuating means to pivot
25 the lever means.

14. Apparatus as claimed in claim 13, wherein the lever means comprises at least one rocker drivably engaging the carrier member by way of a roller.

30 15. Apparatus as claimed in claim 13, wherein the actuating means is disposed outside the vacuum vessel and coupled to the lever means by way of coupling means passing through a vacuum-tight entry passage of the vessel.

16. Apparatus as claimed in claim 15, wherein the actuating means is disposed
35 below the vacuum vessel.

5 17. Apparatus as claimed in claim 13, wherein the actuating means comprises a pneumatic piston-cylinder unit.

18. Apparatus as claimed in claim 1, wherein the release means comprises temporary support means movable upwardly through passage means in the table
10 to provide the temporary substrate support.

19. Apparatus as claimed in claim 18, wherein the temporary support means comprises at least three spaced-apart axially movable support pins defining a plane of temporary support by their upper ends.

15 20. Apparatus as claimed in claim 19, wherein the passage means comprises an individual passage in the table for each support pin.

21. Apparatus as claimed in claim 18, wherein the temporary support means is
20 movable downwardly to a position clear of the holder.

22. Apparatus as claimed in claim 18, wherein the release means comprises drive means to move the temporary support means upwardly and downwardly between a position providing the temporary substrate support and a position
25 permitting removal of the holder from the chamber.

23. Apparatus as claimed in claim 22, wherein the drive means is disposed outside the vacuum vessel and coupled to the temporary support means by way of coupling means passing through a vacuum-tight annexure of the vessel.

30 24. Apparatus as claimed in claim 23, wherein the drive means is disposed below the vessel.

25. Apparatus as claimed in claim 22, wherein the drive means comprises a
35 linear stepping drive.

5 26. Apparatus as claimed in claim 18, wherein the temporary support means is rotationally movable to angularly adjust the position of the temporarily supported substrate relative to the table.

10 27. Apparatus as claimed in claim 26, comprising an adjusting drive drivingly connected to the temporary support means by drive transmission means providing rotary movement of the temporary support means, but accommodating the upward movement of the temporary support means.

15 28. Apparatus as claimed in claim 27, wherein the drive transmission means comprises a rotary member rotatable by the adjusting drive and connected to the temporary support means by a plurality of spaced-apart coupling pins so coupled to a component fixed to the temporary support means as to be secure against relative rotation, but axially displaceable relative to the component.

20 29. Apparatus as claimed in claim 28, wherein the rotary member is rotatably mounted in a wall of the vessel.

25 30. Apparatus as claimed in claim 27, wherein the adjusting drive is disposed outside the vacuum vessel and coupled to the rotary member by coupling means passing through a vacuum-tight entry passage of the vessel.

31. Apparatus as claimed in claim 30, wherein the coupling means comprises a shaft incorporating a flexible portion permitting flexure of the shaft.

30 32. Apparatus as claimed in claim 30, wherein the adjusting drive is disposed laterally of the vessel.

33. Apparatus as claimed in claim 27 wherein the adjusting drive comprises a linear actuator.

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5 34. Apparatus as claimed in claim 27, wherein the adjusting drive is operable
to provide stepless angular adjustment within a range up to substantially half a
degree.

35. Apparatus as claimed in 26, comprising an optical system to determine the
10 angular position of the temporarily supported substrate.

36. Apparatus as claimed in claim 35, wherein the optical system comprises
image generating means for causing generation of an image of part of the
substrate, image detecting means for detecting the image and determining means
15 for comparing the detected image with a reference image and determining
therefrom the angular position of the substrate relative to a target position.

37. Apparatus as claimed in claim 36, wherein the image generating means
comprises a light source and optical transmission means for transmitting light
20 from the source to produce a topographical image of at least part of a top face of
the substrate.

38. Apparatus as claimed in claim 36, wherein the image detecting means
comprises a microscope for detecting the image and a camera for recording the
25 detected image.

39. Apparatus as claimed in claim 36, wherein the determining means
comprises data processing means for software processing of data indicative of the
orientation of the detected image and comparison thereof with data indicative of
30 the orientation of the reference image.

40. Apparatus as claimed in claim 35, wherein the optical system is disposed
above the vacuum vessel.

5 41. Apparatus as claimed in claim 26, comprising control means to control rotational movement of the temporary support means in dependence on the substrate angular position determined by the optical system.

10 42. Apparatus as claimed in claim 26, wherein the temporary support means is additionally movable upwardly and downwardly to bring the top face of the temporarily supported substrate into a focal plane of the optical system.

15 43. Apparatus as claimed in claim 1, wherein the transfer port is disposed to enable lateral transfer of the holder between the region and the loading and unloading chamber.

20 44. Apparatus as claimed in claim 1, wherein the vessel is substantially box-shaped and the apparatus includes housings arranged above and below the vessel and accommodating functional components of the apparatus.

25 45. Apparatus as claimed in claim 1, the apparatus being constructed as a module attachable to a substrate processing machine with a chamber defining the evacuated region.

30 46. A substrate processing machine having an evacuable region incorporating a substrate processing station, the machine being equipped with substrate loading and unloading apparatus as claimed in any one of the preceding claims and communicating with the region by way of the transfer port of the loading and unloading chamber.

35 47. A machine as claimed in claim 46, wherein the region further incorporates a transfer station for transfer of the substrate holder between the processing station and the chamber by way of the transfer port.

40 48. A machine as claimed in claim 46, wherein the machine includes substrate feed means for feeding substrates into and removing substrates from the region.

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49. A machine as claimed in claim 48, wherein the feed means comprises an air lock to preserve a vacuum environment of the region during feed of substrates.

50. A machine as claimed in 47, comprising remotely actuatable transfer means
10 for effecting the holder transfer.

51. A machine as claimed in claim 47, wherein the transfer station additionally serves for transfer of substrates to and from the holder by way of the transfer port when the holder is in the loading and unloading chamber.

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52. A machine as claimed in claim 51, comprising remotely actuatable transfer means for effecting the substrate transfer.

53. A machine as claimed in claim 46, the machine being an electron beam
20 pattern-writing machine for writing patterns on substrates in succession in the processing station.